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BIOAEROSOL CONTAMINATION IN DENTAL CLINIC : A POTENTIAL HEALTH HAZARD ?

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ABSTRACT:. *Dental clinics are potential hazardous areas as large amount of bio-aerosols are produced here. Bioaerosols are microorganisms or particles, gases, vapors, or fragments of biological origin (i.e., alive or released from a living organism) that are in the air. Many sources of bioaerosols exist within and outside the dental clinic. The concentration of aerosols and splatters appears to be highest during dental procedures, especially those generated by some procedures such as ultrasonic scaling, or using a high speed drill. Bioaerosols may reach up to 12-16 feet from the source during patient care and may stay suspended in the air for hours if there is inadequate ventilation of air exchanges. Therefore, several infectious diseases could be transmitted to staff and patients by airborne bacterial and other contaminants in the dental clinic. Dental staff should use personal protective measures, which reduce contact with bacterial aerosols and splatters in the dental clinic.*

KEYWORDS: ***Bioaerosols , Splatter, Dental Unit Water Line(DUWL), Infection***

INTRODUCTION

The potential for diseases to spread via an airborne route has been recognized historically over a long period of time. In dental clinic environment dental professionals and patients are daily exposed to a great variety of infectious agents and toxic substances transported by aerosols and droplets, produced during dental operative procedures, promoting an increased risk of cross infection. Aerosols are small droplets which can remain suspended in air for some time before they settle on environmental surfaces. Mouth fluids are grossly contaminated with bacteria, mostly aerobic bacteria (streptococci and staphylococci) and viruses. Most dental procedures that use hand pieces, turbines, ultrasonic scalers, air polishers and abrasion units removes material from the operative site, that becomes aerosolized by the instrument rotary action or the water sprays and compressed air combined actions; So, there is a strong possibility that aerosols, besides the presence of bacteria, will include viruses, blood, and supra- and sub-gingival plaque organisms. Microorganisms isolated in dental aerosols have been associated with bacterial diseases such as tuberculosis, staphylococcal infection, conjunctivitis, viral infections and other skin infections. Increase in the usage of ultrasonic scalers and turbine hand pieces in recent times caused increase of aerosol contamination and decreased air quality in the dental clinic.

Aerosols and splatter

Aerosols are often defined as droplets <50µm diameter. Exposure to aerosols presents a significant risk because they are invisible to the naked eye and easily inhaled. Particle size greatly influences the site of deposition of these particles in the respiratory tract and the survival of microbes in the aerosol . Smaller particles such as viruses (0.02µm – 0.4µm) and bacteria (0.25µm – 4.0µm) deposit in the lungs and alveoli, while larger particles (>10µm) such as fungi, deposit in the upper respiratory tract. Particle size also determines the suspension time for aerosolized microorganisms. The suspension time may be short (seconds), but it is still long enough to allow transport by moving air currents or other nearby disturbances.

Particles >50µm in diameter are referred to as splatter. These particles are not as easily inhaled and do not remain suspended in the air. Instead, due to their size, they possess kinetic energy and are described to travel in a trajectory similar to a bullet . These particles are more likely to deposit on dental surfaces and the clothes, hair, skin, eyes and mucous membranes of dental personnel. The particles may be absorbed by these surfaces. If not absorbed, they may dry out, evaporate and become smaller particles. These smaller particles, known as droplet nuclei, fall back into the category of aerosols and are capable of being inhaled.

Sources of infection

In most cases, the major source of infection in a dental setting is the patient. Although, the dental unit water line (DUWL) presents a potentially large source of infection as well. There are four basic routes of entry for spreading infectious microorganisms in a dental setting

1. Blood-borne
2. Saliva-droplet
3. Direct contact
4. Water-droplet

The patient is generally the source of the blood-borne and saliva-droplet routes. The third, direct contact, may be from the patient and/or contaminated equipment. The sources of the water-droplet route are biofilms and other microorganisms in the dental unit water line (DUWL).

BLOOD-BORNE

The greatest risks for dental personnel are from blood-borne viral pathogens, such as hepatitis B and C, HIV, and HPV because they can cause serious and life-threatening diseases . The risks posed by these viruses to dental personnel have been thoroughly studied and are considered to be a biological hazard in dentistry .

Hepatitis B virus (HBV) contains DNA and is highly infectious, able to be transmitted by blood and saliva and highly resistant to disinfection and sterilization techniques. This virus may be transmitted to the dental personnel through needle sticks, percutaneous injuries and the aerosolization of blood, saliva and/or gingival secretions.

Hepatitis C virus (HCV) is a blood-borne virus containing RNA; less infectious than HBV, but with no vaccines available, the occupational risk is still high. Also, patients with HCV are more prone to extensive dental disease thereby likely increasing the degree to which dental personnel will be exposed to it .

Human immunodeficiency virus (HIV) is an RNA-containing retrovirus, which causes the acquired immunodeficiency syndrome (AIDS). It is spread through blood and sexual contact. These infections often originate in the oral cavity and should be of great concern to dental personnel. HIV is much less infectious than Hepatitis Band C but due to the mortality rate, dental personnel should exercise extreme caution regarding it.

Human papillomavirus (HPV), primarily types 6 or 11, may rarely result in Recurrent Respiratory Papillomatosis (RRP). HPV is primarily spread through sexual contact, but the presence of RRP in the respiratory tract makes it a potential risk to dental professionals performing dental procedures in the oral cavity.

SALIVA DROPLET AND DIRECT CONTACT

The risks associated with the saliva-borne and direct contact routes include prions, viruses, bacteria and fungi. Herpes simplex virus is one of the better known and studied risk factors spread by this route .

i) VIRUSES: Many viruses are present in the mouth originating from the saliva, gingival tissues, and from the nose, throat, and lungs. These include the common cold, influenza, and herpetic viruses. The greatest current concern is the SARS virus.

Herpes simplex viruses (HSV-1, HSV-2) cause recurrent labial and genital herpes, herpetic whitlow and keratitis. Its particular hazard for dental personnel is due to its common occurrence, high infectivity and asymptomatic state during which the virus has been found in saliva .

SARS (SCoV) – the virus that causes severe acute respiratory syndrome (SARS) – is a virulent coronavirus containing RNA. Because it is a relatively new virus, health care personnel are particularly at risk. This was especially shown to be true during a 2002 epidemic of the virus in which more than 25% of those affected were healthcare workers .

ii) BACTERIA: It is well known that dental plaque, tooth decay and periodontal disease are caused by bacteria. By some estimates, there can be nearly 300-400 species of bacteria in the oral cavity and “one drop of saliva may contain nearly 50,000 bacteria, belonging to 25 genera” . The danger is that many of these bacteria are potentially pathogenic.

Mycobacterium tuberculosis (TB) is carried in droplet nuclei released by individuals with pulmonary or laryngeal tuberculosis disease by coughing, talking, sneezing, etc. Because Tuberculosis is transmitted via the air, there is risk of dentists inhaling TB-contaminated aerosols during dental procedures and becoming infected

iii) FUNGI: Fungi, typically from the Candida genus, and protozoa, such as Pneumocystis carinii, can also be transmitted via the saliva-droplet mode. Candida spp. is very common in the oral cavity, especially amongst denture wearers.

iv) PROTOZOA: The protozoa are less common, but can be a problem with immuno compromised individuals.

WATER-DROPLET

In the case of DUWL, biofilms formed within the lines essentially serve as breeding grounds for these pathogenic microorganisms, presenting them with sufficient nutrients and protection to reproduce, multiply and develop substantial numbers very quickly. Dental unit water lines (DUWL) supply water to multiple hand pieces including the air-water syringe, the ultrasonic scaler, and the high-speed hand piece This water is typically used to not only flush the patient’s mouth but also to cool hand pieces and the patient’s teeth during procedures. The micro bore flexible tubing used in DUWL is the perfect environment for microbial colonization and proliferation because of laminar flow passing through the waterlines.

Microbial contamination of DUWL may come from 3 sources: primary contamination of municipal water, a patient's saliva retracting in the waterlines or dental hand pieces, and biofilms within the tubing system of the dental unit . However, the formation and sloughing off of biofilms is the most important and abundant cause of DUWL contamination . Mature biofilms may contain bacteria, fungi and parasitic organisms .Bacterial species such as Pseudomonas aeuroginosa, Pseudomonas cepacia, Legionella pneumophilia, Mycobacterium chelonae have been identified in biofilms.

Fig.1. Visible coolant water aerosol created by a straight style ultrasonic insert using the standard 17ml/min of coolant water. The actual contaminated aerosol produced during clinical use is much more extensive than the visible aerosol pictured here.

Fig.2. Visible aerosol produced by a straight "slim" style insert using a standard 17ml/min volume of coolant water. The use of a saliva ejector has almost no effect on the aerosol produced even when placed at a much more favorable position (approximately 1 cm from the ultrasonic tip) than is the case clinically. A saliva ejector is ineffective in reducing aerosols

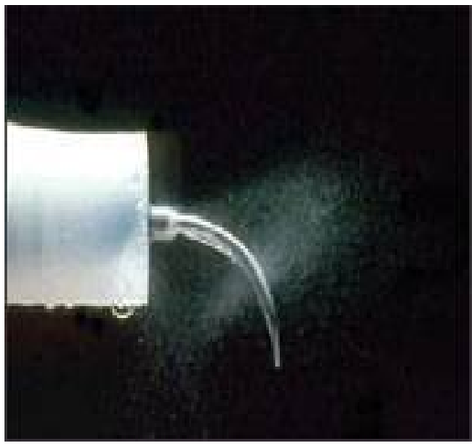

Fig.3. The visible aerosol produced by the same tip and coolant water volume pictured in Figure 1 with a high volume evacuator attached to the handle of the ultrasonic scaler. This high volume evacuation device reduces both coolant water aerosol and bacterial contamination by 95%.

Fig.4. The visible aerosol produced by an air polisher (Prophy-Jet® Cavitron®). Both abrasive particles and water droplets are propelled forcefully against the tooth by compressed air. This force will cause the water and abrasive to ricochet off of the tooth surface and into the air.

METHODS OF REDUCING AIRBORNE CONTAMINATION:

1. Provision of good ventilation with its diluting effect on the airborne microbial load.

2. Reduction in the emission of bacterial dental aerosols which can be attained by:

   a. Flushing of water from ultrasonic scaler device and turbine hand pieces for 5-10 minutes in the beginning of the day and for 2 minutes before treatment.
   b. Use of Pre-Procedural antiseptic mouth rinse (0.2% Chlorhexidine, Povidone Iodine). C. Use of aerosol reduction devices (High volume suction apparatus)
   c. Purification of airborne microbial pollutants (Disinfection with physic al and chemical means)
   d. Rubber dam isolation while using turbine hand pieces.
   e. Minimizing biofilm formation in dental unit water lines - Use of sterile water or sterile saline. - Drain and flush water for several minutes before beginning clinic each day. - Perform periodic chemical treatment as recommended by manufacturers.
   f. Other precautions like use of facemask and face shield. Masks should have at least 95% filtration efficiency y for particles 3.0-5.0µm in diameter. Should be changed for each patient Change of mask after 20minutes in aerosol or 60 minutes in non aerosol environments, Eye Protection; Protective eye wear or face shield must be worn while treating patients

CONCLUSION

The aerosols and splatter produced during dental procedures have the potential to spread infection to dental personnel and other people in dental clinic. It is difficult to completely eliminate the risk posed by dental aerosols; it is possible to minimize the risk with relatively simple and inexpensive precautions like personal barrier protection, preprocedural mouth rinse with an antimicrobial mouth rinse before treatment, use of high volume suction apparatus and use of rubber dam where applicable. The use of these precautions will reduce the risk of an aerosolized spreading of infection to a minimum level.

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